

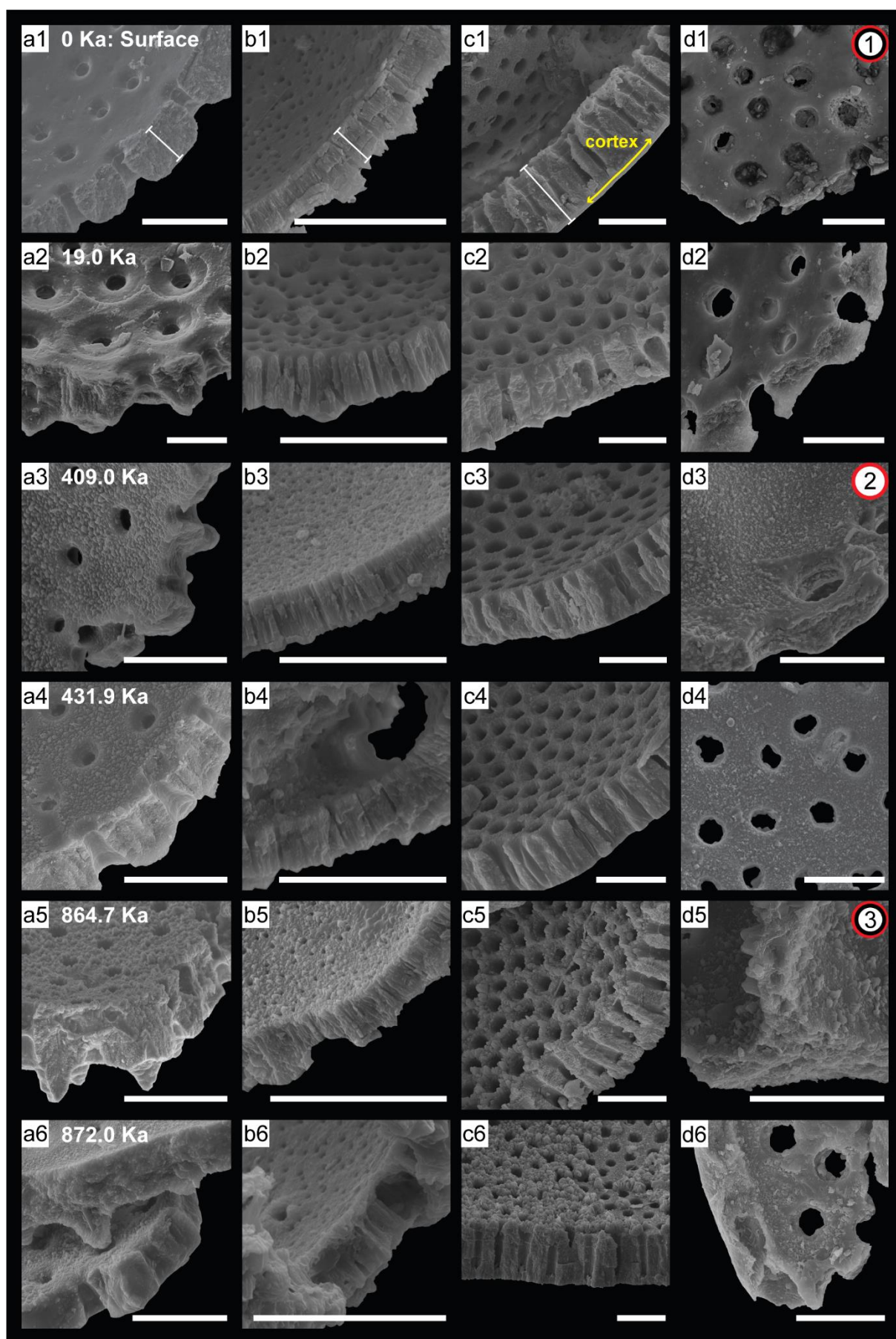
Supplementary Material 1. Representative visual SEM images used to define the Diagenesis Rank (DR) values for the individual species from IODP Expedition 359 Site U1467.

Supplementary Figs. 1a–b.

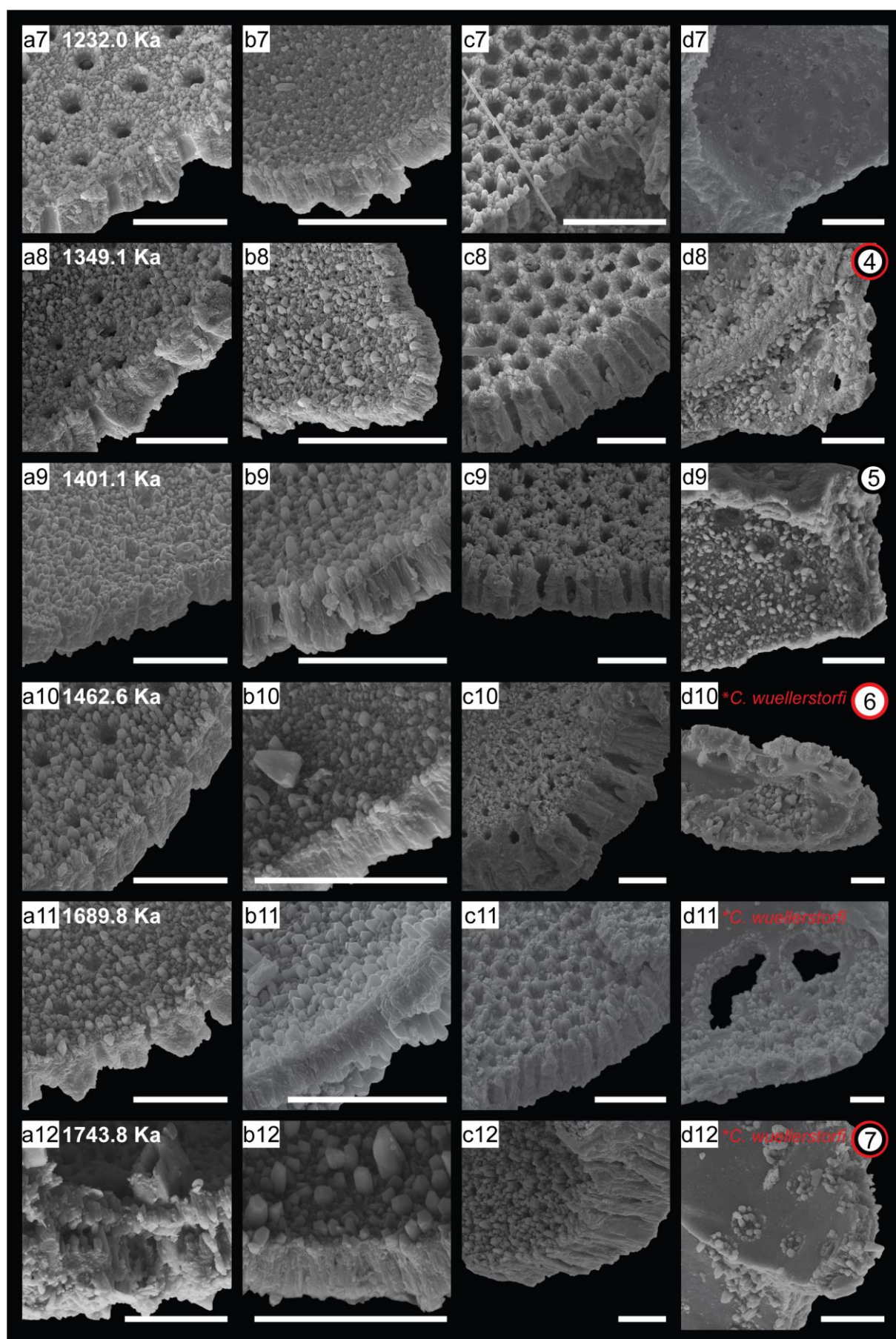
IODP Expedition 359 Site U1467 cross section and inner test surface SEM images of (a) *G. ruber* (w); (b) *G. glutinata* (w/b); (c) *P. obliquiloculata* (w/c) and (d) *C. mabahethi/wuellerstorfi* for Samples: (1) A, B-Mudline; (2) C-1H-1, 99-100 cm; (3) B-3H-3, 9-10 cm; (4) B-3H-3, 102-103 cm; (5) B-4H-5, 36-37 cm; (6) C-4H-3, 87-88 cm; (7) C-5H-4, 30-31 cm; (8) B-6H-2, 75-76 cm; (9) B-6H-3, 75-76 cm; (10) B-6H-4, 75-76 cm; (11) C-6H-5, 57-58 cm; (12) B-7H-3, 75-76 cm. For reference, SIMS and EPMA Samples 1-7 are indicated in the black and red circles, respectively. White bars indicate test thickness. Scale bars = 20 µm.

Supplementary Figs. 1c–d.

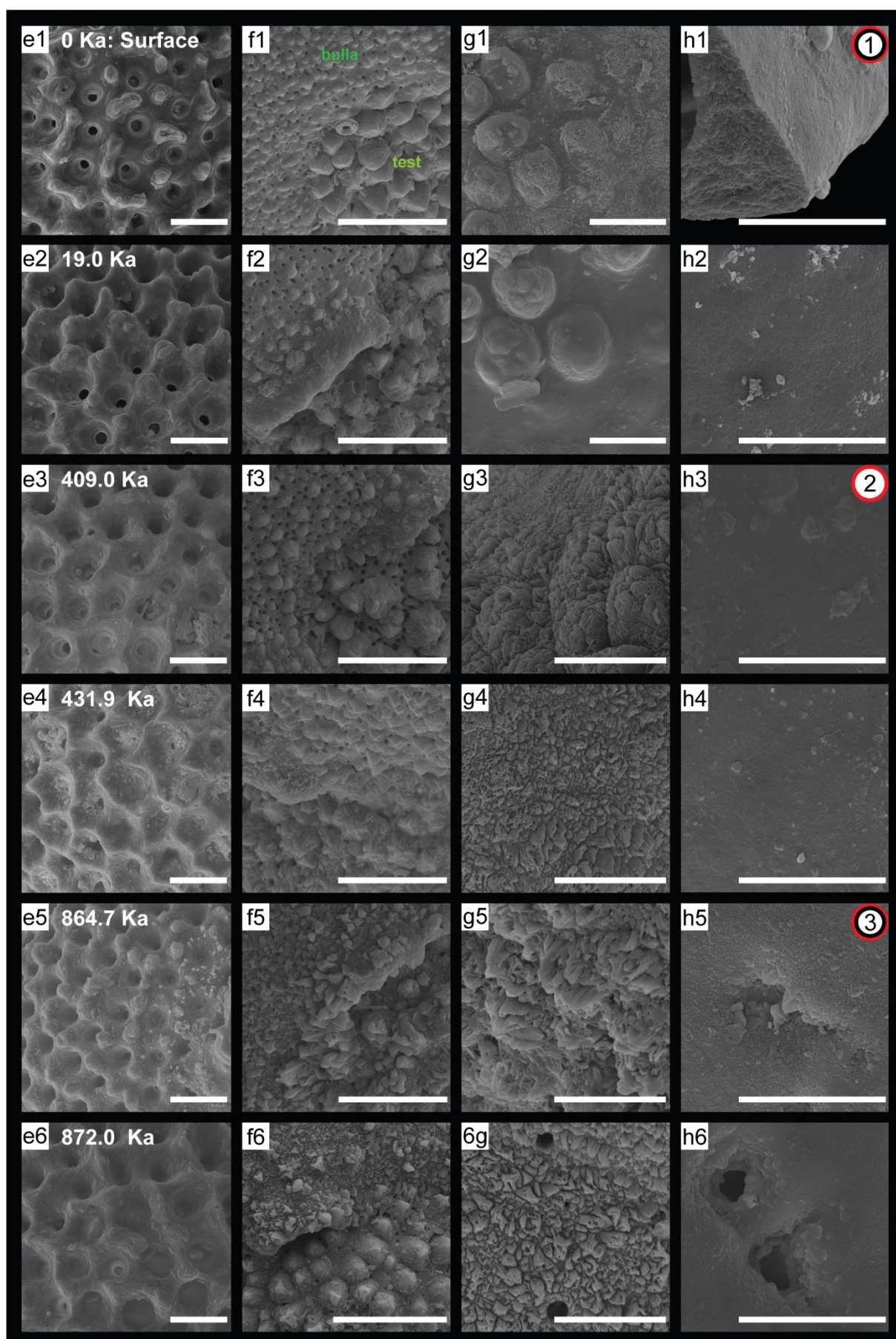
IODP Expedition 359 Site U1467 external test surface SEM images of (e) *G. ruber* (w); (f) *G. glutinata* (w/b); (g) *P. obliquiloculata* (w/c) and (h) *C. mabahethi/wuellerstorfi* for Samples: (1) A, B-Mudline; (2) C-1H-1, 99-100 cm; (3) B-3H-3, 9-10 cm; (4) B-3H-3, 102-103 cm; (5) B-4H-5, 36-37 cm; (6) C-4H-3, 87-88 cm; (7) C-5H-4, 30-31 cm; (8) B-6H-2, 75-76 cm; (9) B-6H-3, 75-76 cm; (10) B-6H-4, 75-76 cm; (11) C-6H-5, 57-58 cm; (12) B-7H-3, 75-76 cm. For reference, SIMS and EPMA Samples 1-7 are indicated in the black and red circles, respectively. Scale bars = 20 µm.



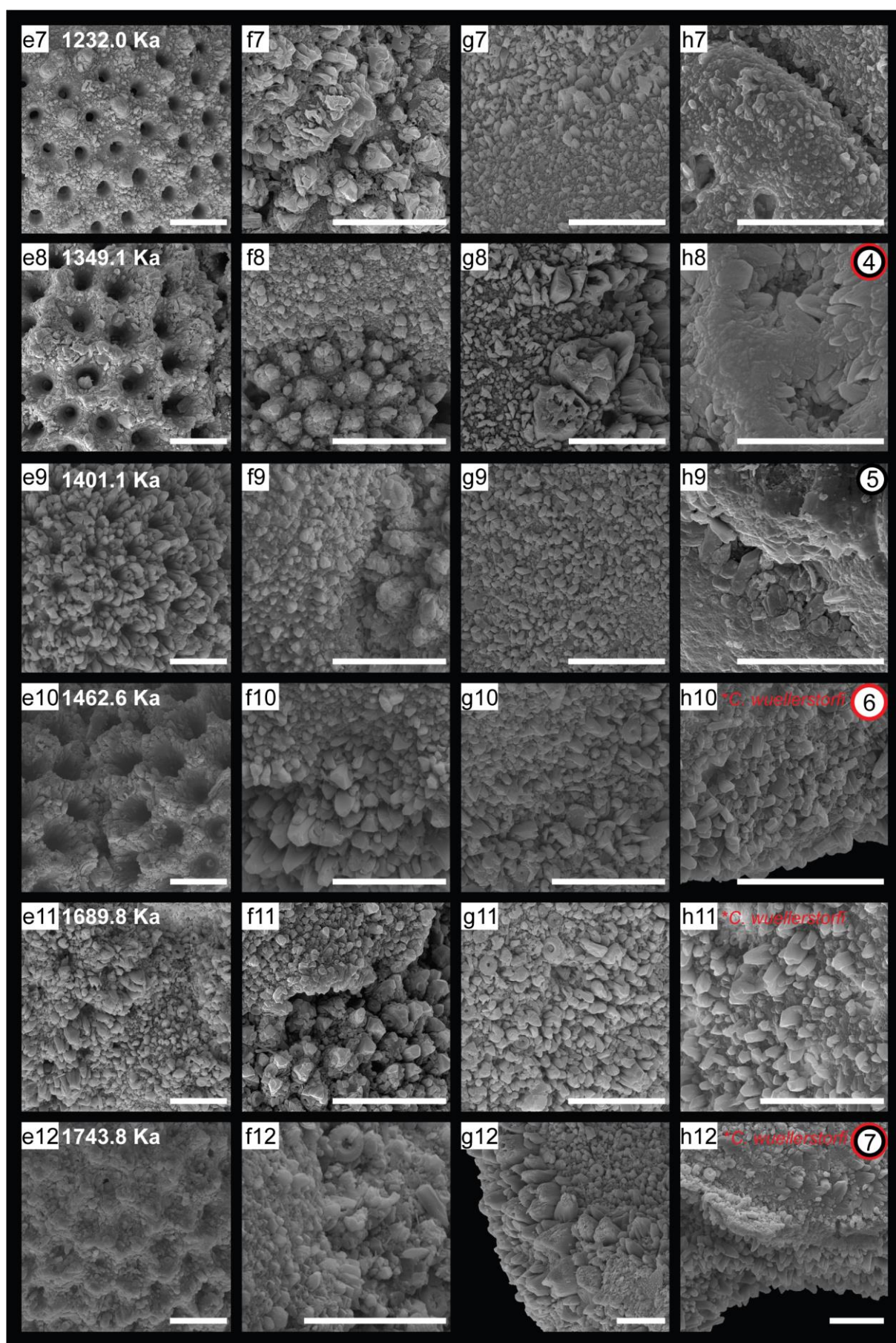
Supplementary Fig. 1a.



Supplementary Fig. 1b.

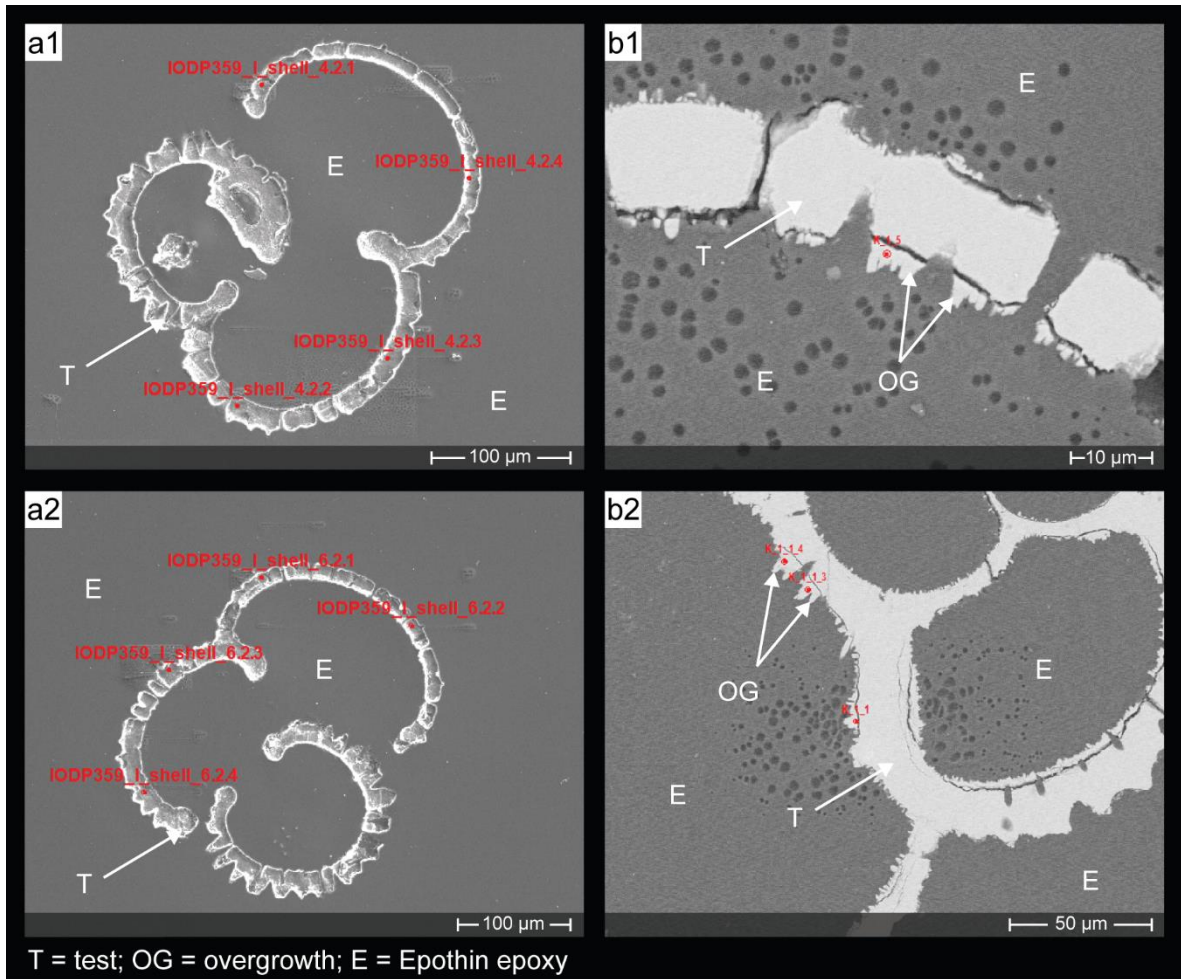


Supplementary Fig. 1c.



Supplementary Fig. 1d.

Supplementary Material 2. Electron Probe Micro-Analyzer (EPMA) data.



Supplementary Fig. 2a. IODP Expedition 359 Site U1467 *G. ruber* (w) SEM images showing examples of EPMA spot measurements for (a) the foraminifera test (T) and (b) large authigenic overgrowths (OG). Samples: (a1) B-4H-5, 36-37 cm; a2) B-6H-2, 75-76 cm; (b1-2) B-6H-4, 75-76 cm (Approximate location of the EPMA spots are shown for reference with the red dots with the red text indicating their individual EPMA IDs).

Supplementary Table 2a. IODP Expedition 359 Site U1467 *G. ruber* (w) EPMA test measurements used in the study. Measurements with total counts < 97 and > 102 were excluded.
Note: SrO was measured for all samples and was zero in all instances.

Sample	EPMA ID	Sample ID	CaO	MgO	C	Total	Chamber	Mg/Ca (mmol/mol)
359-U1467B-Mudline	IODP359_I_shell_1.1.1	1	56.45	0.21	44.53	101.19	F-0	5.17
359-U1467B-Mudline	IODP359_I_shell_1.1.2		56.00	0.26	44.24	100.50	F-0	6.49
359-U1467B-Mudline	IODP359_I_shell_1.2.3		55.23	0.19	43.55	98.97	F-0	4.87
359-U1467B-Mudline	IODP359_I_shell_1.2.4		55.17	0.13	43.44	98.74	F-0	3.25
359-U1467B-Mudline	IODP359_I_shell_1.1.3		55.86	0.13	43.98	99.97	F-1	3.17
359-U1467B-Mudline	IODP359_I_shell_1.1.4		55.40	0.12	43.61	99.13	F-1	3.11
359-U1467B-Mudline	IODP359_I_shell_1.2.2		55.74	0.15	43.91	99.80	F-1	3.70
359-U1467B-3H-3, 9-10 cm	IODP359_I_shell_2.1.1	2	55.55	0.18	43.79	99.52	F-0	4.51
359-U1467B-3H-3, 9-10 cm	IODP359_I_shell_2.1.2		56.30	0.26	44.47	101.03	F-0	6.43
359-U1467B-3H-3, 9-10 cm	IODP359_I_shell_2.2.1		55.37	0.18	43.65	99.20	F-0	4.45
359-U1467B-3H-3, 9-10 cm	IODP359_I_shell_2.2.2		55.41	0.16	43.66	99.23	F-0	3.90
359-U1467B-3H-3, 9-10 cm	IODP359_I_shell_2.1.3		54.98	0.29	43.46	98.73	F-1	7.36
359-U1467B-3H-3, 9-10 cm	IODP359_I_shell_2.1.4		54.82	0.24	43.28	98.34	F-1	6.14
359-U1467B-3H-3, 9-10 cm	IODP359_I_shell_2.2.3		55.31	0.14	43.56	99.01	F-1	3.54
359-U1467B-3H-3, 9-10 cm	IODP359_I_shell_2.2.4		54.71	0.23	43.18	98.12	F-1	5.83
359-U1467B-4H-5, 36-37 cm	IODP359_I_shell_4.1.2	3	54.96	0.21	43.36	98.53	F-0	5.20
359-U1467B-4H-5, 36-37 cm	IODP359_I_shell_4.2.4		55.13	0.19	43.47	98.79	F-0	4.81
359-U1467B-4H-5, 36-37 cm	IODP359_I_shell_4.1.3		55.01	0.20	43.39	98.60	F-1	5.15
359-U1467B-4H-5, 36-37 cm	IODP359_I_shell_4.2.2		55.60	0.14	43.79	99.53	F-1	3.51
359-U1467B-4H-5, 36-37 cm	IODP359_I_shell_4.2.3		55.75	0.18	43.95	99.88	F-1	4.48
359-U1467B-6H-2, 75-76 cm	IODP359_I_shell_6.1.1	4	55.08	0.14	43.39	98.61	F-0	3.64
359-U1467B-6H-2, 75-76 cm	IODP359_I_shell_6.1.3		55.17	0.13	43.44	98.74	F-1	3.32
359-U1467B-6H-2, 75-76 cm	IODP359_I_shell_6.1.4		55.90	0.12	44.00	100.02	F-1	2.96
359-U1467B-6H-2, 75-76 cm	IODP359_I_shell_6.1.5		55.75	0.15	43.92	99.82	F-1	3.79
359-U1467B-6H-2, 75-76 cm	IODP359_I_shell_6.2.4		55.10	0.21	43.47	98.78	F-1	5.41
359-U1467B-6H-4, 75-76 cm	IODP359_I_shell_8.1.2	6	56.90	0.13	44.79	101.82	F-0	3.11
359-U1467B-6H-4, 75-76 cm	IODP359_I_shell_8.3.1		55.22	0.15	43.50	98.87	F-0	3.74
359-U1467B-6H-4, 75-76 cm	IODP359_I_shell_8.1.4		55.32	0.16	43.59	99.07	F-1	4.08
359-U1467B-6H-4, 75-76 cm	IODP359_I_shell_8.3.3		55.49	0.19	43.76	99.44	F-1	4.77
359-U1467B-6H-4, 75-76 cm	IODP359_I_shell_8.3.4		54.92	0.22	43.34	98.48	F-1	5.53
359-U1467B-7H-3, 75-76 cm	IODP359_I_shell_9.1.1	7	56.78	0.14	44.72	101.64	F-0	3.49
359-U1467B-7H-3, 75-76 cm	IODP359_I_shell_9.1.2		55.74	0.15	43.90	99.79	F-0	3.66
359-U1467B-7H-3, 75-76 cm	IODP359_I_shell_9.1.6		55.13	0.12	43.40	98.65	F-1	3.13
359-U1467B-7H-3, 75-76 cm	IODP359_I_shell_9.2.3		55.09	0.18	43.43	98.70	F-1	4.43
359-U1467B-7H-3, 75-76 cm	IODP359_I_shell_9.2.4		55.42	0.17	43.68	99.27	F-1	4.18
359-U1467B-7H-3, 75-76 cm	IODP359_I_shell_9.2.5		54.66	0.17	43.08	97.91	F-1	4.33

Supplementary Table 2b. IODP Expedition 359 Site U1467 *G. ruber* (w) EPMA overgrowth measurements used in the study. Measurements with total counts < 97 and > 102 were excluded. Note: SrO was measured for all samples and was zero in all instances.

Sample	EPMA ID	Sample ID	CaO	MgO	C	Total	Mg/Ca (mmol/mol)
359-U1467B-6H-4, 75-76 cm	K_1_1	6	54.70	0.55	43.52	98.77	13.87
359-U1467B-6H-4, 75-76 cm	K_1_1_4		56.29	0.41	44.62	101.32	10.13
359-U1467B-7H-3, 75-76 cm	K_5_2	7	56.19	0.53	44.67	101.39	13.12
359-U1467B-7H-3, 75-76 cm	K_5_2_b		54.80	1.05	44.15	100.00	26.71
359-U1467B-7H-3, 75-76 cm	K_5_1		54.76	1.01	44.08	99.85	25.76

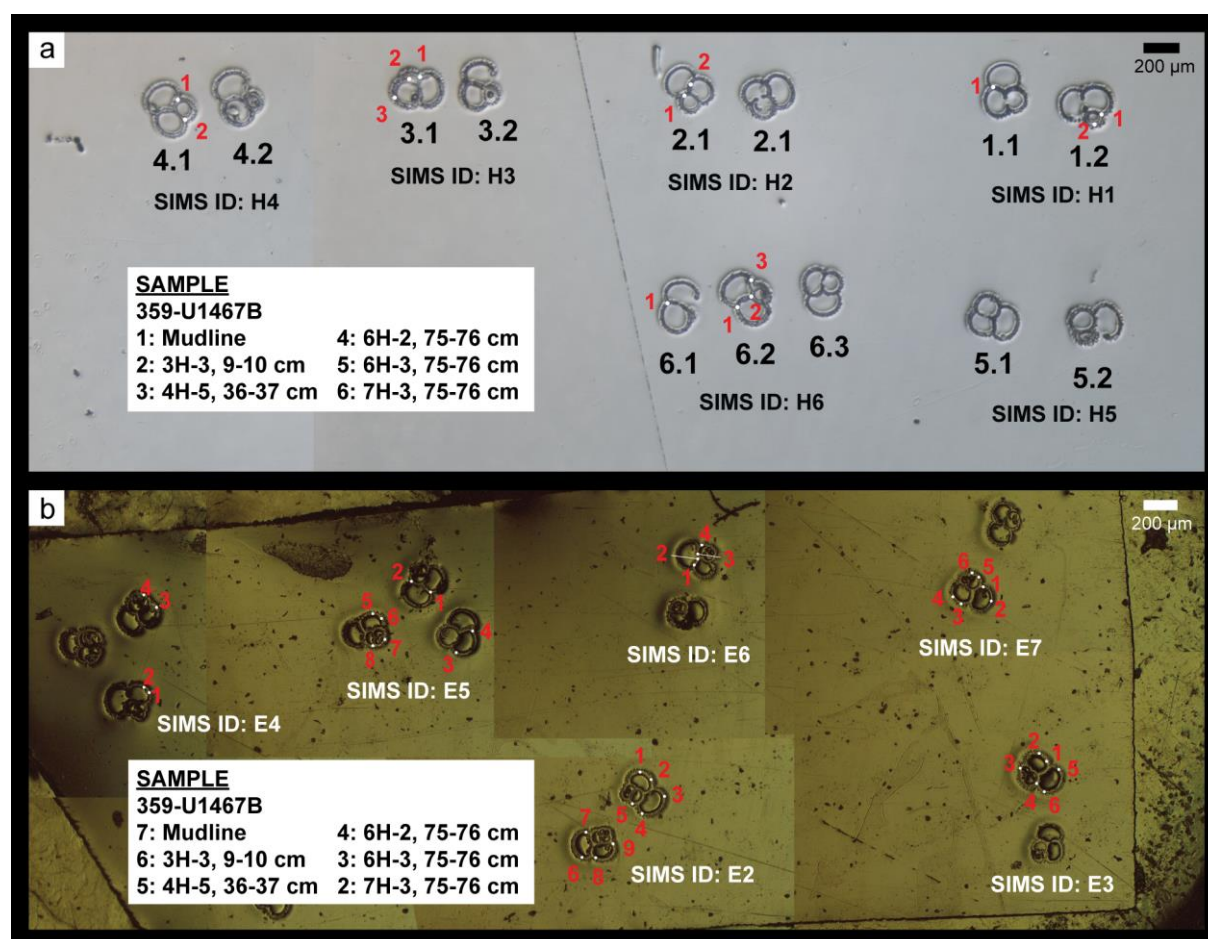
Supplementary Table 2c. IODP Expedition 359 Site U1467 whole-test *G. ruber* (w) Mg/Ca data used in EPMA comparison.*Data is taken from Stainbank et al. (2019).

Sample	Sample ID	Mg/Ca (mmol/mol)
359-U1467B-Mudline	1	5.66*
359-U1467B-Mudline		5.65*
359-U1467B-3H-3, 9-10 cm	2	6.30
359-U1467B-3H-3, 9-10 cm		6.00
359-U1467B-3H-3, 9-10 cm		5.97
359-U1467B-4H-5, 36-37 cm	3	6.18
359-U1467B-4H-5, 36-37 cm		6.22
359-U1467B-6H-2, 75-76 cm	4	6.05
359-U1467B-6H-2, 75-76 cm		5.72
359-U1467B-6H-4, 75-76 cm	6	6.62
359-U1467B-6H-4, 75-76 cm		6.10
359-U1467B-7H-3, 75-76 cm	7	8.45
359-U1467B-7H-3, 75-76 cm		7.32

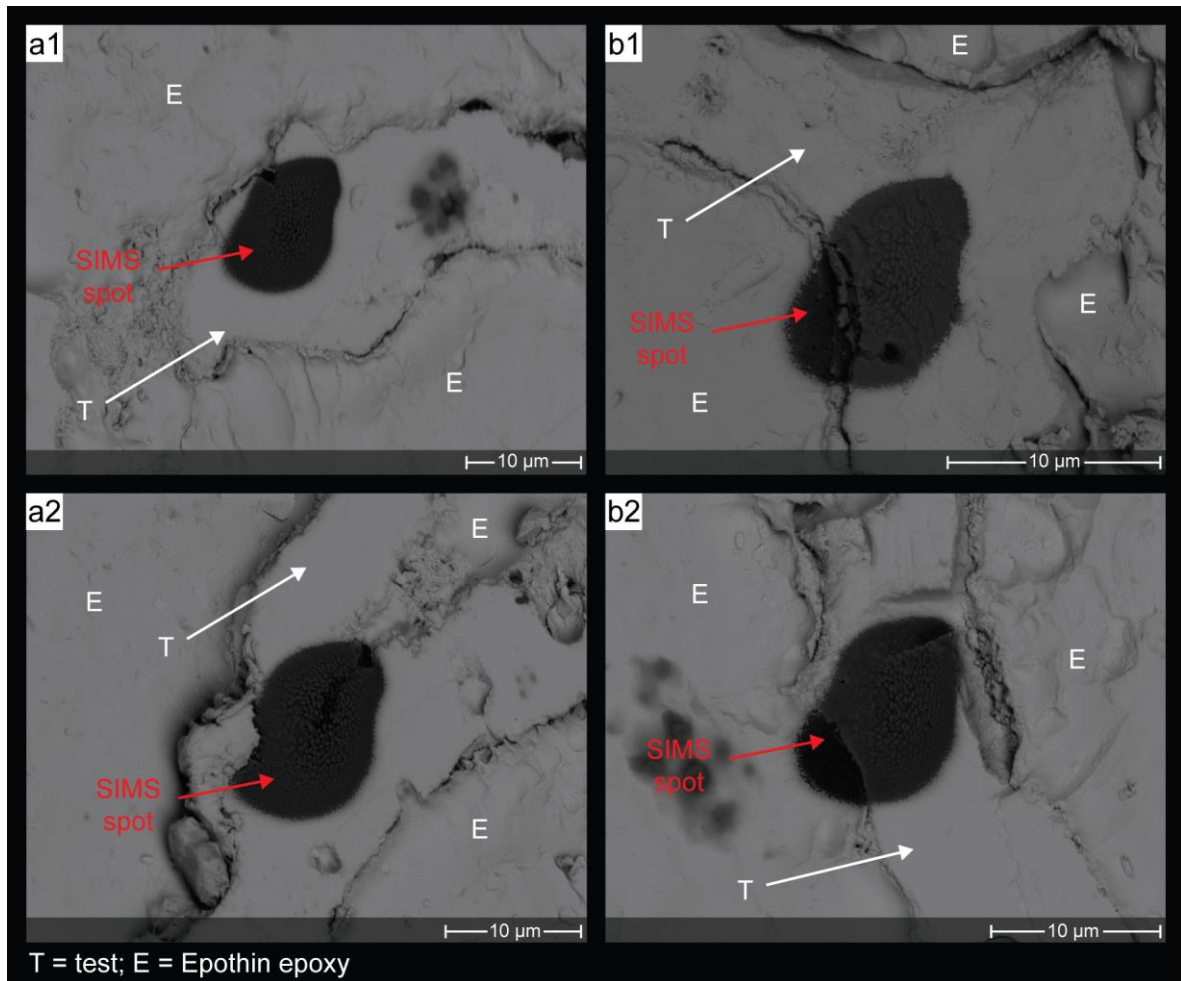
Reference

Stainbank, S., Kroon, D., Rüggeberg, A., Raddatz, J., de Leau, E.S., Zhang, M., Spezzaferri, S., 2019. Controls on planktonic foraminifera apparent calcification depths for the northern equatorial Indian Ocean. PLoS ONE14, e0222299.
<https://doi.org/10.1371/journal.pone.0222299>.

Supplementary Material 3. Secondary Ion Mass Spectrometer (SIMS) data.



Supplementary Fig. 3a. Compilation of IODP Expedition 359 Site U1467 (a) stereomicroscope images of embedded and polished *G. ruber* (w) SIMS Sample H showing approximate SIMS spot locations and (b) transmitted light microscope images of *G. ruber* (w) SIMS Sample E showing approximate SIMS spot locations. Sample IDs are indicated on the image.



Supplementary Fig. 3b. IODP Expedition 359 Site U1467 SEM images showing examples of *G. ruber* (w) SIMS spots which (a) hit only the foraminiferal test (T) and (b) which partly hit the epoxy (E). IODP Expedition 359 Site U1467 Samples: (a1) B-4H-5, 36-37 cm (SIMS ID: $\delta^{18}\text{O}_{\text{foram_H3_1@1}}$); (a2) B-6H-2, 75-76 cm (SIMS ID: $\delta^{18}\text{O}_{\text{foram_H4_1@1}}$); (b1) B-Mudline (SIMS ID: $\delta^{18}\text{O}_{\text{foram_H1_2@1}}$); (b2) B-4H-5, 36-37 cm (SIMS ID: $\delta^{18}\text{O}_{\text{foram_H3_1@3}}$).

Supplementary Table 3a. IODP Expedition 359 Site U1467 *G. ruber* (w) SIMS measurement spots, which hit no epoxy and were used in the study. (Session H-1 standard yield: 1.10E+09; Session E-2 standard yield: 9.30E+08). Bold indicates the SIMS spot, which hit substantial authigenic overgrowth.

Sample	SIMS ID	Sample ID	Session	Yield	$\delta^{18}\text{O}$ (‰)	2se (‰)	Chamber
359-U1467B-Mudline	$\delta^{18}\text{O}_{\text{foram_E7@4}}$	1	E-2	1.021E+09	-2.08	0.35	F-1
359-U1467B-4H-5, 36-37 cm	$\delta^{18}\text{O}_{\text{foram_H3_1@1}}$	3	H-1	1.093E+09	-2.70	0.38	F-0
359-U1467B-4H-5, 36-37 cm	$\delta^{18}\text{O}_{\text{foram_E5@6}}$		E-2	8.728E+08	-2.22	0.29	F-1
359-U1467B-4H-5, 36-37 cm	$\delta^{18}\text{O}_{\text{foram_E5@7}}$		E-2	9.644E+08	-2.14	0.39	F-2
359-U1467B-4H-5, 36-37 cm	$\delta^{18}\text{O}_{\text{foram_E5@8}}$		E-2	9.468E+08	-2.81	0.30	F-2
359-U1467B-4H-5, 36-37 cm	$\delta^{18}\text{O}_{\text{foram_H3_1@2}}$		H-1	1.043E+09	-2.82	0.50	F-2
359-U1467B-6H-2, 75-76 cm	$\delta^{18}\text{O}_{\text{foram_H4_1@1}}$	4	H-1	1.049E+09	-1.75	0.35	F-0/F-2
359-U1467B-6H-2, 75-76 cm	$\delta^{18}\text{O}_{\text{foram_H4_1@2}}$		H-1	1.065E+09	-2.63	0.38	F-2
359-U1467B-6H-3, 75-76 cm	$\delta^{18}\text{O}_{\text{foram_E3@1}}$	5	E-2	1.078E+09	-2.15	0.34	F-1
359-U1467B-6H-3, 75-76 cm	$\delta^{18}\text{O}_{\text{foram_E3@2}}$		E-2	9.996E+08	-2.51	0.43	F-1
359-U1467B-7H-3, 75-76 cm	$\delta^{18}\text{O}_{\text{foram_E2@1}}$	7	E-2	9.859E+08	-1.55	0.44	F-1
359-U1467B-7H-3, 75-76 cm	$\delta^{18}\text{O}_{\text{foram_E2@2}}$		E-2	9.881E+08	-2.18	0.39	F-1
359-U1467B-7H-3, 75-76 cm	$\delta^{18}\text{O}_{\text{foram_H6_1@1}}$		H-1	1.045E+09	-2.00	0.26	F-1
359-U1467B-7H-3, 75-76 cm	$\delta^{18}\text{O}_{\text{foram_H6_2@1}}$		H-1	9.555E+08	-1.24	0.41	F-1
359-U1467B-7H-3, 75-76 cm	$\delta^{18}\text{O}_{\text{foram_H6_2@2}}$		H-1	1.025E+09	-3.15	0.38	F-2
359-U1467B-7H-3, 75-76 cm	$\delta^{18}\text{O}_{\text{foram_H6_2@3}}$		H-1	1.035E+09	-2.12	0.27	F-2

Supplementary Material 4. Table 4a. Age model data for IODP Expedition 359 Site 1

Tie-points

359-U1467B, C Depth (mcd)	Prob-stack (Ahn et al., 2017) Age (kyr)	Sedimentation rate (cm/kyr)
0.01	0	8.1
0.58	7	3.9
0.85	14	3.0
1.00	19	2.0
1.06	22	2.3
1.15	26	3.0
1.18	27	1.5
1.63	57	2.2
1.87	68	3.0
2.32	83	15.0
2.77	86	9.5
3.15	90	4.9
3.54	98	4.5
3.81	104	2.6
4.02	112	15.0
4.17	113	4.5
4.44	119	6.0
4.50	120	9.0
4.59	121	9.5
4.78	123	13.5
5.05	125	3.6
5.41	135	3.6
5.59	140	2.6
6.16	162	2.3
6.70	186	3.9
7.21	199	4.5
7.30	201	9.0
7.39	202	9.8
7.78	206	11.0
8.11	209	12.0
8.47	212	3.7
8.62	216	5.6
9.07	224	5.0
9.72	237	16.3
10.21	240	2.7
10.48	250	4.4
11.35	270	5.1
12.12	285	7.5
12.27	287	5.1
12.78	297	2.5
13.05	308	2.1
13.20	315	12.6
13.83	320	6.4
14.28	327	10.5

14.49	329	9.0
14.67	331	3.0
14.73	333	2.4
14.85	338	4.5
14.94	340	9.0
15.03	341	0.9
15.09	348	2.3
15.18	352	3.0
15.24	354	1.2
15.30	359	3.3
15.60	368	5.1
16.47	385	1.5
16.53	389	4.6
17.13	402	3.0
17.25	406	6.0
17.31	407	3.0
17.37	409	3.0
17.76	422	5.0
18.21	431	10.5
18.42	433	2.3
18.79	449	2.6
18.97	456	2.1
19.30	472	3.3
19.60	481	5.4
19.87	486	8.2
20.20	490	1.8
20.56	510	1.5
20.59	512	1.1
20.68	520	5.6
21.85	541	3.0
22.06	548	1.2
22.27	566	4.1
22.96	583	4.5
23.14	587	6.0
23.38	591	6.8
23.92	599	15.0
24.07	600	7.5
24.22	602	1.2
24.34	612	2.3
24.76	630	3.3
25.09	640	1.5
25.87	692	3.5
26.08	698	2.5
26.68	722	8.7
27.55	732	4.3
28.15	746	1.2
28.60	784	2.0
28.96	802	2.5

29.47	822	4.2
29.89	832	2.6
30.31	848	6.8
31.12	860	4.5
31.30	864	4.5
31.66	872	3.0
32.14	888	3.3
32.80	908	2.8
33.13	920	1.7
33.67	952	4.2
34.18	964	3.0
34.60	978	3.4
34.87	986	5.7
35.44	996	4.1
35.77	1004	2.2
36.16	1022	2.4
36.55	1038	3.0
36.67	1042	1.5
36.70	1044	0.9
36.82	1058	1.5
36.97	1068	6.8
37.24	1072	1.2
37.57	1100	1.5
37.69	1108	11.3
38.14	1112	2.7
38.41	1122	2.3
38.50	1126	1.7
39.10	1162	5.3
41.11	1200	5.7
42.94	1232	11.5
43.63	1238	1.1
43.81	1254	2.5
44.26	1272	9.6
45.22	1282	6.0
45.58	1288	4.1
46.57	1312	8.2
46.90	1316	5.3
47.11	1320	1.3
47.32	1336	2.1
47.65	1352	2.5
48.10	1370	2.6
48.31	1378	3.0
48.73	1392	7.5
49.03	1396	1.2
49.24	1414	1.5
49.72	1446	1.5
49.87	1456	10.9
50.74	1464	5.2

51.16	1472	2.6
51.58	1488	5.4
52.12	1498	0.7
52.27	1520	4.2
52.48	1525	3.0
52.78	1535	0.4
52.84	1550	1.9
53.08	1563	1.6
53.32	1578	1.9
53.56	1590	6.0
53.71	1593	2.6
54.04	1605	0.4
54.07	1613	0.9
54.16	1623	1.8
54.25	1628	0.9
54.34	1638	1.4
54.52	1650	1.8
54.61	1655	2.3
55.18	1680	8.5
57.10	1703	2.8
57.52	1718	5.6
57.94	1725	4.6
58.51	1738	2.4
58.75	1748	6.8
59.26	1755	9.0
60.16	1765	1.7
60.55	1788	3.0
60.70	1793	4.0
61.00	1800	3.4

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